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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**  
**APPLICATION FOR LETTERS PATENT**

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**TITLE : ADAPTIVE BACKPLANE SYSTEM FOR ELECTRONIC CARDS**

## **CROSS REFERENCE TO RELATED APPLICATION**

This application is based upon U.S. Provisional Patent Application No. 60/428,909, filed November 26, 2002, entitled "ADAPTIVE BACKPLANCE SYSTEM FOR ELECTRONIC CARDS", which is currently pending.

## **FIELD OF THE INVENTION**

The present invention relates generally to electronic board packaging systems. More specifically the invention concerns a system for debugging and integrating bus - based cards such as CompactPCI in which a transition card facility is supplemented. The invention also concerns an adaptive backplane system that can fit in space constrained locations.

## **BACKGROUND OF THE INVENTION**

Printed circuit boards (PCBs) are used for interconnecting, mounting and packaging electronic components such as integrated circuits. The boards (cards) can be arranged in card cages which provide a constructional framework for sets of cards. This is illustrated schematically in **Fig. 1**, which is a configuration typical of CompactPCI standard card cages and to which reference is now made. Backplane, (referred to also as motherboard) **10** is disposed within card cage **12**. Backplane **10**, bears eight connectors **14**, unto which boards can be plugged.

A plug - in card is connected to the backplane as described schematically in **Fig. 2A** to which reference is now made. Male connector **16** harbors the female

connector **18** onto which the board **20** is affixed. In the CompactPCI connectors, as described in Fig. **2B**. Male connector **22** contains pins **24** which accomplish the electric connection between the card (not shown) and the backplane to which it is plugged.

Owing to the compact configuration standards of the backplane system such as in the VME and in the CompactPCI (cPCI), the access to any location on the plugged – in board, except for peripheral sites, is difficult. Probes of test equipment have to be physically connected to specific terminals on the plugged – in boards, typically disposed in card cages. For developers of hardware systems the accessibility to components and test points on the cards is an exceptionally important issue, primarily for debugging of the circuits and their integration with the software. Three strategies for enhancing the accessibility into such cards are presently employed:

1. Leaving vacant connectors in standard card cages. Such an undertaking leaves more room for probes to be connected to the cards' components and test points. The extra accessibility is gained however at the cost of empty connector, which downgrades system integration capabilities.
2. Installing dedicated debugging ports and test points on the cards, which are relatively easily accessible through the front panel, even when installed in card cages.
3. Using card cages dedicated for ease of accessibility.

A previously employed strategy, namely the extender card arrangement, is no longer popular among developers. This disinclination stems from the significant influence that such an arrangement has on signal integrity, and from the limitation on bug reconstruction that such an arrangement confers.

Some backplane systems use a supplementary set of card slot in the rear side of the backplane as is schematically shown in **Fig. 3** to which reference is now made. On both surfaces of backplane card are arranged male connectors.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic prior art description of a backplane card disposed within a card cage;

Fig. 2A is a schematic isometric description of a plugged – in card in a prior art connector of a backplane card;

Fig. 2B is a schematic description of a connector of a backplane showing the arrangement of pins in a connector of a backplane of the prior art;

Fig. 3 is a schematic description of a backplane system of the prior art containing two set of connectors on both sides of the backplane;

Fig. 4 is a schematic isometric view showing a bent flexible card of the invention;

Fig. 5 is a schematic description of a portion of a backplane card of the invention with supplementary cards;

Fig. 6 is a schematic enlarged view of a backplane system of the invention showing an appended rigid domain and plugged in cards;

Fig. 7A is a schematic description of a rigid domain pair of backplane system of the invention;

Fig. 7B is a schematic enlarged view of the connection between the rigid domains of a rigid domain pair of the invention;

Fig. 8 is a schematic view of a ruggedized section of an ABP of the invention, showing brackets;

Fig. 9 is a schematic view of a section of an ABP showing two rigid domain pairs showing the folded layers connecting the appended rigid domains with the backplane rigid domains;

Fig. 10A is a schematic description of a swivel connection between backplane rigid domain and an appended matching rigid domain;

Fig. 10B is a schematic description of a swivel connection between backplane rigid domain and an appended matching rigid domain, with the pivot drawn out;

Fig. 11A is a schematic description of a link connector aligned with a swivel connection and the pivot thereof drawn out on its axis;

Fig. 11B is a schematic description of a link connector in a near attached position;

Fig. 12A is a schematic side view description of a backplane system of the invention, wherein link members are interconnected;

Fig. 12B is a schematic side view description of a backplane system of the invention, wherein link members are interconnected and some rigid domains have moved with respect to their positions as described in Fig. 12A;

Fig. 13 is a schematic description of the applicable electrical connection schemes between matching rigid domains in accordance with the present invention;

Fig. 14 is a general description of a backplane system of the invention including cards and supplementary card, showing ejectors and legs.

## **Summary of the invention**

The present invention provides an articulated electronic card retainer system that can be implemented in a bus – based card - caged systems such as VME or CompactPCI electronic card standards. The mechanical flexibility of the system allows relative easy access to components and test points on the plug – in cards.

In one embodiment of the present invention, a bracketed plug – in card provides a mechanical strengthening benefit. The bracket stabilizes mechanically the connection between the plug – in card and the backplane, a connection which is subjected to excessive mechanical strains in the flexible backplane.

In accordance with one aspect of the present invention, a mechanically enhanced, flexible backplane in the form of an articulated PCB (printed circuit board) is provided. Typically a backplane system of the invention implements a set of transition cards, connected to the PCB by a matching set of connectors carried by rigid domains. To further mechanically secure the flexible backplane of the invention, a chain link member is provided, for connecting mechanically rigid domain pairs and facilitate a secure yet relatively free relative movement of the two members of the pair.

## DETAILED DESCRIPTION OF THE PRESENT INVENTION

In accordance with the present invention, an articulated backplane (ABP) is provided, in which rigid domains bearing the male backplane connectors, alternate with flexible inter – connector domains (FD). This conformation is better explained in reference to **Fig. 4** which illustrates schematically a ABP generally designated **30** in accordance with an embodiment of the invention. Rigid members (RM) **32** of the PCB bear each a male connector **34** which is capable of harboring a compatible electronic card such as cards **36**. Besides the rigid domains, the card of the invention includes at least one flexible domain **38**. Male connector **34** harbors a female connector **40** onto which the card **36** is affixed. The geometrical dimensions and electrical properties of the connectors and the space between them are defined by the appropriate standard, such as VME, or CompactPCI and must not impair signal integrity.

The FDs are flexible due to their reduced thickness and their constitution. For example, the RMs of the invention are made, typically, like common PCBs, of 6 – 32 layers of rigid fiberglass typically impregnated with epoxy or polyimide. The FD is made of 2 – 32 layers of flexible plastic resin, typically Kapton® polyimide with no fiberglass reinforcement.

### VME and cPCI backplane card architecture

The present invention provides an electronic card retainer that can be implemented in any bus – based card - caged systems such as the above electronic card standards. The mechanical flexibility of the system allows the developer to gain relative easy access to components and test points on the plug – in cards. For this



reason, the system of the present invention is particularly beneficial for those developers who occasionally or frequently have a need for probing the components and test points on the cards in the course of development and integration of bus – based, card – caged systems.

In one embodiment of the present invention, a bracketed plug – in card was described which provided a mechanical strengthening benefit. The bracket stabilizes mechanically the connection between the plug – in card and the backplane, a connection which is subjected to excessive mechanical strains in the flexible backplane.

In accordance with one aspect of the present invention, a mechanically enhanced, flexible backplane (ABP) in the form of an articulated PCB (printed circuit board) is provided. Typically a backplane system of the invention implements a set of transition cards, connected to the PCB by a matching set of connectors. The architectural features of this aspect of the invention are better explained with reference to **Fig. 5**. The ABP **44**, of which only a portion is shown, includes rigid domains (RDs) such as RD **46**, onto which connectors, such as connector **48** are affixed. A plug – in card **50** is inserted into the respective RD, through mating connector **52** to which the plug – in card **50** is attached. In the other side of the ABP, a transition card (TC) **54** is inserted into the respective RD through connector **56**. The configuration of the ABP of the invention at the level of the RDs is better explained with reference to **Fig. 6**, which is an enlarged schematic view of the connection between plug – in cards and the RDs.

Connector **58**, is plugged in connector **60** which is affixed to a backplane rigid domain (BPRD) **62**. An appended rigid domain (ARD) **64** bears a connector **66** into which a matching card connector **68** is plugged.

### **The electric connections between the BPRD and the matching ARD**

As can be seen in **Fig. 6**, each BPRD contains a set of continuous layers **70** running through the BPRDs of the ABP. In accordance with a preferred embodiment of the invention, the BPRD contain two sets of flexible layers. The connection between the ARDs of the ABP is maintained by the circuits associated with the layers out of which the ABP is made. Some of the layers contain the circuits which maintain the electric connections between the ARDs and connection to the ports and other connections on the ARD on the ABP.

In **Fig. 7A** to which reference is now made, the layers **72** are folded in a different folding scheme. This folding scheme allows more flexibility of the supplementary card positioning relative to the BPRD and associated card. In **Fig. 7B** an enlarged view of the folding scheme shows how the flexible layers are folded, connecting opposite sides of the front and rear ARDs. The relationship between BPRD **76** and the ARD **78**, which constitute a rigid domain pair is such that their relative movement is more slack than in the tighter folding schemes.

### **Plug – in board brackets and ruggedization**

In **Fig. 8** to which reference is now made, a BPRD **82** into which a plug – in card **84** is installed is fitted with a bracket **86**. The ARD **88** is also fitted with bracket **90**, which corresponds in length with the height of plug – in card **92**. The adjacent RD pair **94** is shown without plug – in cards and brackets. In **Fig. 9** to which reference is now made, two adjacent RD pairs of a ABP are shown. Bracket **98** is applied to BPRD **100**

and another bracket **102** is applied to the respective ARD **104**. An adjacent RD pair **106** is connected by a flexible domain to BPRD **100**.

### **Mutually securing the BPRD and the matching ARD**

To enhance the ruggedness of the backplane system of the invention, yet keep it flexible for convenient access into the plugged - in boards, further measures are taken. In **Fig. 10A** to which reference is now made, another aspect of the invention is described schematically in which a swivel connecting between a BPRD and the matching ARD is provided. Accordingly, to ARD **110**, associated with bracket **112**, are attached swivel members **114**. Swivel members **114** are each pivotally fitted to the matching swivel members **116**, which are attached to BPRD **118**. Bracket **120** is associated with BPRD **118**. In **Fig. 10B** the same construction is shown, with the pivot **122** drawn out along its axis out of the pivot's bore **124**. Pivot **122** locks the two members of the RD pair together allowing rotational movement around the pivot.

### **Stretch and twist limiter chain**

To further mechanically secure the flexible backplane of the invention, a chain link member is provided. From the interlinked plurality of which links a mechanically securing chain is made. The chain thus applied provides a limit to the twist and stretch that can be imposed on the backplane of the invention. To describe the limiter chain, reference is now made to **Fig. 11A**. Link member **170** contains four holes, of which **172** is used for driving a fastening means such as a rivet to pivot **122**, shown drawn out on its axis **123**. The two lateral holes **174** and **176** are used for pivotally connecting the link member **170** to adjacent link members (not shown). In **Fig. 11B** the link member **170** is

shown in a near fastened position, whereby the link member **170** is approached to the RD pair for locking. Hole **178** is used for fastening link member **170** to the pivot (not shown). Figure **12A** is a schematic side view of a portion of a backplane of the invention, with the link members such as link **180** installed. The link member **180**, is disposed between the pair members BPRD **182** and ARD **184**. Link **180** is connected pivotally to link member **186** at hole **188**, such that a relative rotational movement between the link members can be achieved. Each member of the RD pair, for example ARD **180** and BPRD **182** can perform relative rotational movement around the axis **190**. In a preferred embodiment of the invention, the link members such as link member **180**, are fixed to one bracket of the RD pair. This fixation is typically performed by affixing element such as a rivet or a screw **192**.

The relative movement of the two members of the RD pair is further described in **Fig. 12B** to which reference is now made. BPRD **194** and ARD **196** constitute a rigid domain pair (RD pair). BPRD **194** has moved in the direction of arrow **198** around pivot **200**, whereas ARD **196** has remained static with respect to the pivot **200**. ARD **202** turns around pivot **204** together with link member **206**, to which it is attached.

In **Fig. 13** a schematic description of the applicable connecting schemes between matching rigid domains. ARD **220** and BPRD **222** constitute a rigid domain pair. The electrical connection between the two members of the pair is maintained through a right side flexible connection **224**. ARD **228** and BPRD **230** constitute another rigid domain pair, in this pair the electric connection is maintained through a left side flexible connection **232**. In another rigid domain pair, ARD **234** and BPRD **236** are interconnected by a folded flexible connection **238**. In **Fig. 14** to which reference is now

made, a complete system of a backplane and included front or main cards such as card **250**, and rear supplementary cards such as card **252**. Legs **254** support the backplane system, providing stability which is required in the course of handling and probing the backplane system. Ejectors such as ejectors **256** are required for retrieving the plugged cards. The cards which are forcibly pushed into the multi – pin connector are ejected usually by applying a force provided by the leveraging of the ejectors. In accordance with the present invention, each injector is pivoted on a bracket pivot thereby facilitating forceful retrieval of the card.

The mechanical flexibility of the backplane system of the invention is nevertheless an advantage that can be used for applications in which space is a very limited such that bending or convoluting a backplane system may become useful. Such extreme requirements for space are typical of vehicles, especially of aerospace carriers, as well as in ships and submarines and ships. To fully express the utility of the flexible backplane as a flexible structure for either handling or for permanent deployment, a flexible card cage is advantageously used. The flexible card cage, which may be articulated, can be bent or convoluted, yet provide the backplane system an external protection.